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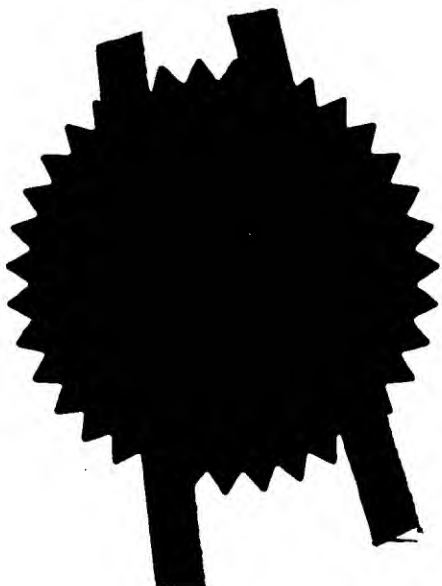
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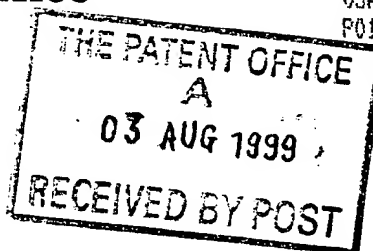
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DESCRIPTION

RADIO COMMUNICATION SYSTEM

5 The present invention relates to a radio communication system having a random access packet channel for the transmission of data packets from a secondary station to a primary station, and further relates to primary and secondary stations for use in such a system and to a method of operating such a system. While the present specification describes a system with particular
10 reference to the emerging Universal Mobile Telecommunication System (UMTS), it is to be understood that the techniques described are equally applicable to use in other mobile radio systems. In this specification the term random access packet channel refers to the logical channel on which random access packet transmissions take place, which would typically consist of a
15 number of distinct physical channels.

A random access channel is a normal component of a radio communication system, enabling a Mobile Station (MS) to send short messages to a Base Station (BS). Applications include signalling to the BS
20 when the MS is turned on, sending a packet of data to the BS when the MS may not be engaged in a call, and requesting the BS to allocate a resource for the MS to use.

In a system where mobile stations often have a requirement to send packets of data to the BS when not actually engaged in a call it is
25 advantageous to provide a random access packet channel with similar characteristics to a standard random access channel but intended for the transmission of small and medium sized packets from a MS to the BS.

In an embodiment of a such a scheme developed for UMTS, there are a number of random access packet channels available to a MS. A request for
30 access to a packet channel sent by the MS is encoded with a randomly-chosen signature, which corresponds to one of the packet channels. If the channel is available for use, the BS allocates it to the requesting MS.

Because of the random choice of signature, it is possible that a MS is denied access to its selected packet channel even if there are other suitable channels available for use. This problem can lead to significant delays for a MS, as well as increased interference and loss of capacity.

5

An object of the present invention is to provide improved allocation of a random access packet channel to a MS.

According to a first aspect of the present invention there is provided a radio communication system comprising a primary station and a plurality of secondary stations and having a random access packet channel for the transmission of data packets from a secondary station to the primary station, the primary and secondary stations having means for engaging in an access phase comprising the secondary station transmitting an access preamble encoded with a first signature and the primary station transmitting an access acknowledgement, and means for engaging in a contention resolution phase on completion of the access phase, the contention resolution phase comprising the secondary station transmitting a contention resolution preamble encoded with a second signature and the primary station transmitting a contention resolution acknowledgement, characterised in that the primary station has means for selecting a packet channel to which the secondary station will be granted access and means for signalling which packet channel has been allocated at the same time as at least one of the access and contention resolution acknowledgements is transmitted to the secondary station, and in that the secondary station has means for transmitting data packets on its allocated packet channel.

25

According to a second aspect of the present invention there is provided a primary station for use in a radio communication system having a random access packet channel for the transmission of data packets from a secondary station to the primary station, the primary station having means for engaging in an access phase comprising the secondary station transmitting an access preamble encoded with a first signature and the primary station transmitting an access acknowledgement, and means for engaging in a contention resolution

30

phase on completion of the access phase, the contention resolution phase comprising the secondary station transmitting a contention resolution preamble encoded with a second signature and the primary station transmitting a contention resolution acknowledgement, characterised in that means are provided for selecting a packet channel to which the secondary station will be granted access and means for signalling which packet channel has been allocated at the same time as at least one of the access and contention resolution acknowledgements is transmitted to the secondary station.

According to a third aspect of the present invention there is provided a secondary station for use in a radio communication system having a random access packet channel for the transmission of data packets to a primary station, the secondary station having means for engaging in an access phase comprising the secondary station transmitting an access preamble encoded with a first signature and the primary station transmitting an access acknowledgement, and means for engaging in a contention resolution phase on completion of the access phase, the contention resolution phase comprising the secondary station transmitting a contention resolution preamble encoded with a second signature and the primary station transmitting a contention resolution acknowledgement, characterised in that means are provided for determining from signals transmitted by the primary station, at the same time as at least one of the access and contention resolution acknowledgements, which packet channel has been allocated, and means are provided for transmitting data packets on the allocated packet channel.

According to a fourth aspect of the present invention there is provided a method of operating a radio communication system having a random access packet channel for the transmission of data packets from a secondary station to a primary station, the method comprising the primary and secondary stations engaging in an access phase comprising the secondary station transmitting an access preamble encoded with a first signature and the primary station transmitting an access acknowledgement, and a contention resolution phase on completion of the access phase, the contention resolution phase comprising the secondary station transmitting a contention resolution preamble

encoded with a second signature and the primary station transmitting a contention resolution acknowledgement, characterised by the primary station selecting a packet channel to which the secondary station will be granted access and signalling which packet channel has been allocated at the same time as at least one of the access and contention resolution acknowledgements is transmitted to the secondary station, and by the secondary station transmitting data packets on its allocated packet channel.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, wherein:

Figure 1 is a block schematic diagram of a radio communication system;

Figure 2 illustrates a basic random access packet channel scheme;

Figure 3 is a table showing one possible set of 16 preamble signatures;

Figure 4 illustrates an enhanced random access packet channel scheme having a packet channel availability message; and

Figure 5 is a flow chart illustrating a method in accordance with the present invention for improved allocation of a random access packet channel.

In the drawings the same reference numerals have been used to indicate corresponding features.

Referring to Figure 1, a radio communication system comprises a primary station (BS) 100 and a plurality of secondary stations (MS) 110. The BS 100 comprises a microcontroller (μ C) 102, transceiver means (Tx/Rx) 104 connected to antenna means 106, power control means (PC) 107 for altering the transmitted power level, and connection means 108 for connection to the PSTN or other suitable network. Each MS 110 comprises a microcontroller (μ C) 112, transceiver means (Tx/Rx) 114 connected to antenna means 116, and power control means (PC) 118 for altering the transmitted power level. Communication from BS 100 to MS 110 takes place on a downlink channel 122, while communication from MS 110 to BS 100 takes place on an uplink channel 124.

A basic scheme for a random access packet channel operating in a frequency division duplex system is shown in Figure 2, with the uplink channel 124 drawn above the downlink channel 122. In an access phase, the MS 110 first transmits a preamble (P) 202, encoded with a signature randomly chosen from a set of 16 possible signatures, at a low power level in a particular access slot.

A signature is a signal characterised by its scrambling code and channelisation code modulated by a specific bit sequence. A mutually orthogonal set of signatures can be obtained by defining a set of mutually orthogonal bit sequences for the modulation. One example of such a set is shown in Figure 3, the set comprising 16 signatures P_0 to P_{15} . Each signature P_i comprises 16 complex symbols S , each of which is either A or $-A$, where $A=1+j$. The inverse of each signature is obtained by interchanging A and $-A$. The signatures and their inverses are all mutually orthogonal.

A different set of signatures can be obtained by changing the scrambling code or the channelisation code (i.e. the physical channel), or by using a different mutually orthogonal set of bit sequences. Alternatively a larger set of signatures may be defined in such a way as to have low cross correlations, rather than strict orthogonality. Although the present specification refers to sets of 16 signatures different implementations may use sets having different numbers of signatures.

In this basic scheme the choice of preamble signature for encoding the access preamble 202 determines the physical channel requested by the MS 110, with each preamble signature corresponding to a limited number of uplink and downlink channels. If the BS 100 receives and decodes the preamble correctly it transmits a preamble acknowledgement (A) 206. In the example shown in Figure 2, after the first preamble 202 is transmitted no acknowledgement is returned in the slot 204 allocated for it (which might typically be 1ms in length). The MS 110 therefore transmits another preamble 202 at a higher power level. Again no acknowledgement is received in the slot 204, so the MS 110 transmits another preamble 202 at a still higher power.

This is received and decoded by the BS 100, which transmits an acknowledgement 206 and thereby completes the access phase.

As well as informing the MS 110 that its preamble 202 has been received, the acknowledgement 206 may be positive, to signal that the requested channels are free, or negative, to signal that they are in use and access is denied to the MS 110. A negative acknowledgement (NACK) may be indicated by the BS 100 inverting the phase of the signature (with respect to some reference or pilot signal). Alternatively, some of the signatures used by the BS 100 for acknowledgement may also be used as a NACK.

10 The BS 100 will only transmit one acknowledgement for each access slot, however many preambles 202 were transmitted. One basis for the selection could be to acknowledge the preamble 202 received with the highest power. If more than one preamble 202 was transmitted but each preamble was encoded with a different signature then each MS 110 will know whether or not its preamble 202 was received correctly. However, it is possible that more than one MS 110 selected the same signature, and therefore believes that its preamble 202 has been received. If each of these mobile stations 110 begins to transmit its data the result will be a collision, with none of the data likely to be received correctly.

20 To reduce the chances of this happening, a contention resolution phase follows the transmission of an acknowledgement 206 which indicated that the requested channels were free. Each MS 110 which transmitted a preamble 202 encoded with a signature corresponding to that acknowledged by the BS 100 now transmits a further contention resolution preamble (CP) 208. This preamble 208 is encoded with a signature randomly selected from another set of 16 possible signatures. This set may be different from the set used for the access preamble 202 (either by changing the set of modulating bit sequences, the scrambling code or the channelisation code), or alternatively the set of signatures may be shared between access and contention resolution phases.

25

30 The BS 100 then issues a contention resolution acknowledgement (CA) 210 corresponding to the selected preamble 208, for example that received with the highest power, which acknowledgement 210 enables the MS 110 to

transmit its data. Hence, if more than one MS 110 selected the same access preamble 202 the chance of the same contention resolution preamble 208 also being selected is small.

After this contention resolution phase the BS 100 begins transmission of
5 a Physical Control CHannel (PCCH) 212, which includes power control information to instruct the MS 110 to adjust its transmission power as necessary, and the MS 110 transmits one or more data packets (PKT) 214 on the allocated packet channel, which is normally on a different physical channel to those used for the preamble transmissions. The PCCH 212 may begin
10 simultaneously with the transmission of the data 214, or may precede it sufficiently for closed loop power control to be established before the data transmission.

A particular problem with the basic scheme described above is that a MS 110 may be denied access to a packet channel corresponding to its
15 selected preamble signature, even though other suitable channels may be available. This makes it likely that a MS 110 will spend significant time waiting for a channel to become available, particularly when traffic loading is high.

In a system in accordance with the present invention, this problem is alleviated by enabling the BS 100 to signal allocation of a packet channel at
20 the same time as it transmits an access acknowledgement 206 or a contention resolution acknowledgement 210. This signalling may form part of the acknowledgement 206,210 or may be transmitted at the same time, preferably with the same channelisation code. In an alternative embodiment of the present invention, illustrated in Figure 4, the BS 100 also transmits a packet
25 channel availability (AV) message 402 to enable a MS 110 to determine whether its required channel is available before requesting access. Such a method is disclosed in more detail in our co-pending patent application (our reference PHB 34369).

Further details of the present invention will be explained with reference
30 to Figure 5, which is a flow chart summarising a method in accordance with the present invention for improved allocation of a random access packet channel to a MS 110. The method starts, at step 502, with a MS 110 having data for

transmission on the random access packet channel. The MS 110 receives, at step 504, the AV message 402 which gives information on available channels and bit rates. One possible format for this message is a three-bit word, sent once in every 10ms frame, indicating the highest available bit rate (in kbps) from the set (0, 60, 120, 240, 480, 960, 1920). A particularly convenient location for this message in a UMTS embodiment is as part of a paging indicator channel (PICH), which has 12 unused bits per frame (or in another physical channel having the same channelisation code as the PICH but only occupying the space left by the unused bits in the PICH).

10 The MS 110 determines, at step 506, whether the required bit rate is available. If the available bit rate is zero, or the MS 110 determines that the available bit rate is not sufficient, then the process restarts at step 504. If the available bit rate is sufficient, the MS 110 can proceed. Before proceeding the MS 110 may wait for a short random back-off period, preferably of up to one frame, to reduce the probability of excessive collisions if a number of MS's 110 simultaneously determine that the same resource is free.

When it proceeds, the MS 110 selects a bit rate (which is equal to or less than the maximum currently available) and sets its transmission power to a minimum power level. This power level is typically determined by the MS 110 using open loop power control, so that a MS 110 is not at a disadvantage compared to another MS 110 nearer to the BS 100. The MS 110 then transmits, at step 508, an access preamble 202 encoded using a signature corresponding to the selected bit rate. Each of the available signatures is mapped to a single bit rate for the packet channel, and a corresponding PCCH 212. The set of available signatures, and mappings between signatures and bit rates, could for example be regularly broadcast by the BS 100. If there is more than one signature available corresponding to its required bit rate the MS 110 selects one at random.

30 The MS 110 now determines, at step 510, whether it has received an acknowledgement 206 from the BS 100. If no acknowledgement is received the MS 110 increases its transmission power, at step 512, and returns to step 508. If an acknowledgement is received the MS 110 determines, at step 514,

whether the acknowledgement was positive, in which case the process continues, or negative, in which case the MS 110 waits for a random back-off period and returns to step 504.

Next the MS 110, at step 516, transmits a contention resolution preamble 208 using a randomly selected signature. The BS 100 acknowledges at most one of the contention resolution preambles 208, and at the same time indicates the channelisation code for the PCCH 212 and the scrambling code for the uplink packet channel. With a choice of 16 signatures and their inverses it is possible to acknowledge up to 16 different preamble signatures with one code word, and at the same time to send another code word indicating one of up to 16 different channelisation codes. To avoid the case of needing to transmit a signature and its inverse at the same time, the signatures may be divided into two sets. The first set and its inverses are used for acknowledgements 210, while the second set and its inverses are used for channel assignments.

Finally, the MS 110 determines, at step 518, whether it received a contention resolution acknowledgement 210 from the BS 110. If a CA 210 was received the MS 110 is able to proceed to transmit, at step 520, its data packets 214 on the assigned channel, after which the method ends at step 522. If no CA 210 was received, the MS 110 waits for a random back-off period and returns to step 504. In this case it is preferable for the MS 110 to keep its transmission power set to the same level as that for the original preamble 202 that appeared to be acknowledged by the BS 100.

The method in accordance with the present invention described above has a number of advantages. The flexibility of the system is improved, since any combination of uplink bit rates can be used (within the capability of the BS 100 or the limit of resources allocated to the packet channel). To achieve this flexibility in known systems requires frequent updating of broadcast parameters. Sending the CA 210 at the same time as the channel allocation minimises delay, while increasing the probability that the MS 110 can obtain access to a packet channel even if many of the available channels are in use.

If only a limited set of signatures is available for contention resolution a multi-stage process can be used, involving the transmission of two or more contention resolution preambles 208 and corresponding acknowledgements 210. The signatures used for successive preambles 208 can be chosen from the same set or from further sets. Such a process is described in our co-
5 pending application GB9914926.2 (our reference PHB 34352). In this case the channel allocation information could also be split between the contention resolution phases (and possibly also shared with the access acknowledgement 206). Alternatively the channel allocation information could
10 be repeated in each acknowledgement 206, 210.

The packet channel availability message 402 uses only 3 bits per frame, which is a very low overhead considering the saving in downlink signalling at times of high loading. An update rate of once per frame is a reasonable compromise between downlink overhead and delay, since the overall
15 transmission delay will be dominated by the time taken to transmit the data packets 214, typically a few frames. By preventing the MS 110 from attempting to transmit unless it has an indication that a suitable resource is available, interference is minimised and the MS 110 saves power. These modifications will increase the overall throughput of the packet channel under high load
20 conditions.

Instead of having an availability message 402, a MS 110 could monitor system activity to determine what packet channels are likely to be free. However, this requires the MS 110 to monitor for an extended period before transmitting, and the information obtained may not be completely reliable.
25 Hence, given its low overhead, the availability message 402 is preferred.

As well as its application in a FDD system as described above, the present invention could be applied in other types of communication system. For example, it could be used in a Time Division Multiple Access (TDMA) system provided that the uplink transmissions take place in different time slots
30 to the downlink transmissions.

From reading the present disclosure, other modifications will be apparent to persons skilled in the art. Such modifications may involve other

features which are already known in the design, manufacture and use of radio communication systems and component parts thereof, and which may be used instead of or in addition to features already described herein. Although claims have been formulated in this application to particular combinations of features, 5 it should be understood that the scope of the disclosure of the present application also includes any novel feature or any novel combination of features disclosed herein either explicitly or implicitly or any generalisation thereof, whether or not it relates to the same invention as presently claimed in any claim and whether or not it mitigates any or all of the same technical 10 problems as does the present invention. The applicants hereby give notice that new claims may be formulated to such features and/or combinations of features during the prosecution of the present application or of any further application derived therefrom.

- In the present specification and claims the word "a" or "an" preceding an 15 element does not exclude the presence of a plurality of such elements. Further, the word "comprising" does not exclude the presence of other elements or steps than those listed.

CLAIMS

1. A radio communication system comprising a primary station and a plurality of secondary stations and having a random access packet channel for the transmission of data packets from a secondary station to the primary station, the primary and secondary stations having means for engaging in an access phase comprising the secondary station transmitting an access preamble encoded with a first signature and the primary station transmitting an access acknowledgement, and means for engaging in a contention resolution phase on completion of the access phase, the contention resolution phase comprising the secondary station transmitting a contention resolution preamble encoded with a second signature and the primary station transmitting a contention resolution acknowledgement, characterised in that the primary station has means for selecting a packet channel to which the secondary station will be granted access and means for signalling which packet channel has been allocated at the same time as at least one of the access and contention resolution acknowledgements is transmitted to the secondary station, and in that the secondary station has means for transmitting data packets on its allocated packet channel.

20

2. A system as claimed in claim 1, characterised in that the primary and secondary stations have means for engaging in a plurality of contention resolution phases on completion of the access phase.

25 3. A system as claimed in claim 1 or 2, characterised in that the primary station has means for transmitting the channel allocation signalling at the same time as each of the access and contention resolution acknowledgements.

30 4. A system as claimed in claim 1 or 2, characterised in that the primary station has means for subdividing the channel allocation signalling into a plurality of portions, and means for transmitting each of the portions at the

same time as a respective one of the access and contention resolution acknowledgements.

5 5. A system as claimed in any one of claims 1 to 4, characterised in that the primary station has means for including the allocation signalling as part of the access and/or contention resolution acknowledgements.

10 6. A system as claimed in any one of claims 1 to 5, characterised in that the primary station has means for regularly transmitting a packet channel status message indicating the highest data rate available on the packet channel.

15 7. A system as claimed in claim 6, characterised in that the primary station has means for transmitting the packet channel status message during unused bits in a paging indicator channel, using the same channelisation code as that channel.

20 8. A system as claimed in claim 7, characterised in that the packet channel status message is a 3 bit word.

25 9. A primary station for use in a radio communication system having a random access packet channel for the transmission of data packets from a secondary station to the primary station, the primary station having means for engaging in an access phase comprising the secondary station transmitting an access preamble encoded with a first signature and the primary station transmitting an access acknowledgement, and means for engaging in a contention resolution phase on completion of the access phase, the contention resolution phase comprising the secondary station transmitting a contention resolution preamble encoded with a second signature and the primary station transmitting a contention resolution acknowledgement, characterised in that
30 means are provided for selecting a packet channel to which the secondary

station will be granted access and means for signalling which packet channel has been allocated at the same time as at least one of the access and contention resolution acknowledgements is transmitted to the secondary station.

5

10. A primary station as claimed in claim 9, characterised in that means are provided for engaging in a plurality of contention resolution phases on completion of the access phase.

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11. A primary station as claimed in claim 9 or 10, characterised in that means are provided for transmitting the channel allocation signalling at the same time as each of the access and contention resolution acknowledgements.

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12. A primary station as claimed in claim 9 or 10, characterised in that means are provided for subdividing the channel allocation signalling into a plurality of portions, and for transmitting each of the portions at the same time as a respective one of the access and contention resolution acknowledgements.

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13. A primary station as claimed in any one of claims 9 to 12, characterised in that means are provided for including the allocation signalling as part of the access and/or contention resolution acknowledgements.

25

14. A primary station as claimed in any one of claims 9 to 13, characterised in that means are provided for regularly transmitting a packet channel status message indicating the highest data rate available on the packet channel.

30

15. A primary station as claimed in claim 14, characterised in that means are provided for transmitting the packet channel status message during unused bits in a paging indicator channel, using the same channelisation code as that channel.

5

16. A secondary station for use in a radio communication system having a random access packet channel for the transmission of data packets to a primary station, the secondary station having means for engaging in an access phase comprising the secondary station transmitting an access preamble encoded with a first signature and the primary station transmitting an access acknowledgement, and means for engaging in a contention resolution phase on completion of the access phase, the contention resolution phase comprising the secondary station transmitting a contention resolution preamble encoded with a second signature and the primary station transmitting a contention resolution acknowledgement, characterised in that means are provided for determining from signals transmitted by the primary station, at the same time as at least one of the access and contention resolution acknowledgements, which packet channel has been allocated, and means are provided for transmitting data packets on the allocated packet channel.

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17. A secondary station as claimed in claim 16, characterised in that means are provided for engaging in a plurality of contention resolution phases on completion of the access phase.

25

18. A method of operating a radio communication system having a random access packet channel for the transmission of data packets from a secondary station to a primary station, the method comprising the primary and secondary stations engaging in an access phase comprising the secondary station transmitting an access preamble encoded with a first signature and the primary station transmitting an access acknowledgement, and a contention resolution phase on completion of the access phase, the contention resolution phase comprising the secondary station transmitting a contention resolution

30

preamble encoded with a second signature and the primary station transmitting a contention resolution acknowledgement, characterised by the primary station selecting a packet channel to which the secondary station will be granted access and signalling which packet channel has been allocated at the same time as at least one of the access and contention resolution acknowledgements is transmitted to the secondary station, and by the secondary station transmitting data packets on its allocated packet channel.

19. A method as claimed in claim 18, characterised by the primary and secondary stations engaging in a plurality of contention resolution phases on completion of the access phase.

20. A method as claimed in claim 18 or 19, characterised by the primary station transmitting the channel allocation signalling at the same time as each of the access and contention resolution acknowledgements.

21. A method as claimed in claim 18 or 19, characterised by the primary station subdividing the channel allocation signalling into a plurality of portions, and transmitting each of the portions at the same time as a respective one of the access and contention resolution acknowledgements.

22. A method as claimed in any one of claims 18 to 21, characterised by the primary station including the allocation signalling as part of the access and/or contention resolution acknowledgements.

23. A method as claimed in any one of claims 18 to 22, characterised by the primary station regularly transmitting a packet channel status message indicating the highest data rate available on the packet channel.

24. A method as claimed in claim 23, characterised by the primary station transmitting the packet channel status message during unused bits in a

paging indicator channel, using the same channelisation code as that channel.

25. A radio communication system substantially as hereinbefore
5 described with reference to and as shown in the accompanying drawings.

26. A primary station constructed and arranged to operate
substantially as hereinbefore described with reference to and as shown in the
accompanying drawings.

10

27. A secondary station constructed and arranged to operate
substantially as hereinbefore described with reference to and as shown in the
accompanying drawings.

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28. A method of operating a radio communication system
substantially as hereinbefore described with reference to and as shown in the
accompanying drawings.

ABSTRACT

RADIO COMMUNICATION SYSTEM

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A radio communication system has a random access packet channel for the transmission of data packets (214) from a secondary station to a primary station. Such a channel is intended for use by secondary stations having packets of data (214) to transmit to a primary station while not actually engaged in a call.

A problem with known systems of this type is that a secondary station requesting access also specifies which of a plurality of channels it wishes to access. If that channel is busy access is denied, even if other suitable channels are available. In the present system allocation of a channel is performed by the primary station when acknowledging (206,210) a secondary station's access attempt (202,208), thereby eliminating wasted attempts. In one embodiment the primary station also broadcasts a short message every frame indicating the availability of channels for access attempts.

20

(Figure 4)

1/3

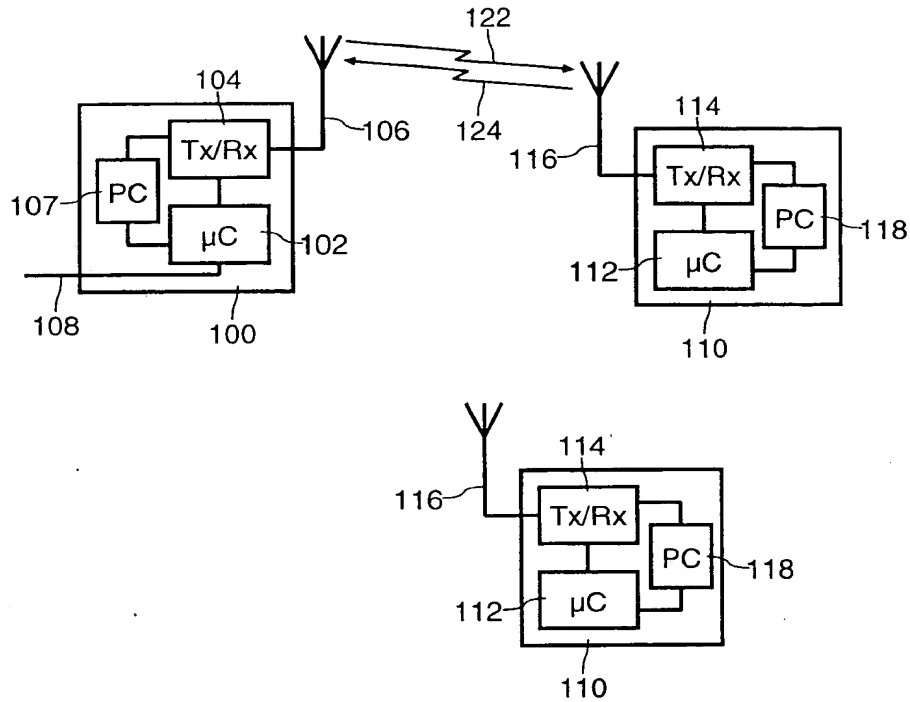


FIG. 1

<i>S</i>	<i>P</i> ₀	<i>P</i> ₁	<i>P</i> ₂	<i>P</i> ₃	<i>P</i> ₄	<i>P</i> ₅	<i>P</i> ₆	<i>P</i> ₇	<i>P</i> ₈	<i>P</i> ₉	<i>P</i> ₁₀	<i>P</i> ₁₁	<i>P</i> ₁₂	<i>P</i> ₁₃	<i>P</i> ₁₄	<i>P</i> ₁₅
1	A	A	A	-A	-A	-A	A	-A	-A	A	A	-A	A	-A	A	A
2	-A	A	-A	-A	A	A	A	-A	A	A	A	-A	-A	A	-A	A
3	A	-A	A	A	A	-A	A	A	-A	A	A	A	-A	A	-A	A
4	-A	A	-A	A	-A	-A	-A	-A	-A	A	-A	A	-A	A	A	A
5	A	-A	-A	-A	-A	A	A	-A	-A	-A	-A	A	-A	-A	-A	A
6	-A	-A	A	-A	A	-A	A	-A	A	-A	-A	A	A	A	A	A
7	-A	A	A	A	-A	-A	A	A	A	-A	-A	-A	-A	-A	-A	A
8	A	A	-A	-A	-A	-A	-A	A	A	-A	A	A	A	A	-A	A
9	A	-A	A	-A	-A	A	-A	A	A	A	-A	-A	-A	A	A	A
10	-A	A	A	-A	A	A	-A	A	-A	-A	A	A	-A	-A	A	A
11	A	A	A	A	A	A	-A	-A	A	A	-A	A	A	-A	-A	A
12	A	A	-A	A	A	A	A	A	-A	-A	-A	-A	A	A	A	A
13	A	-A	-A	A	A	-A	-A	-A	A	-A	A	-A	-A	-A	A	A
14	-A	-A	-A	A	-A	A	A	A	A	A	A	A	A	-A	A	A
15	-A	-A	-A	-A	A	-A	-A	A	-A	A	-A	-A	A	-A	-A	A
16	-A	-A	A	A	-A	A	-A	-A	-A	-A	A	-A	A	A	-A	A

FIG. 3

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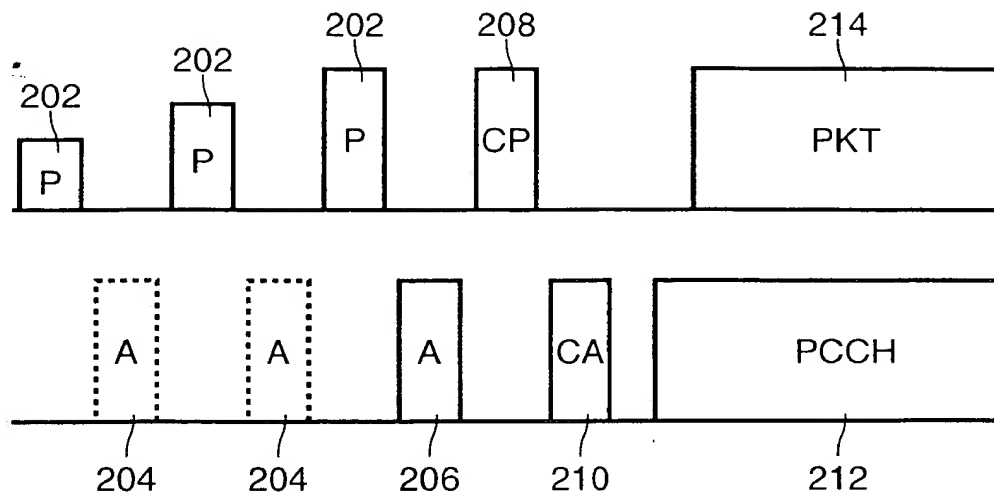


FIG. 2

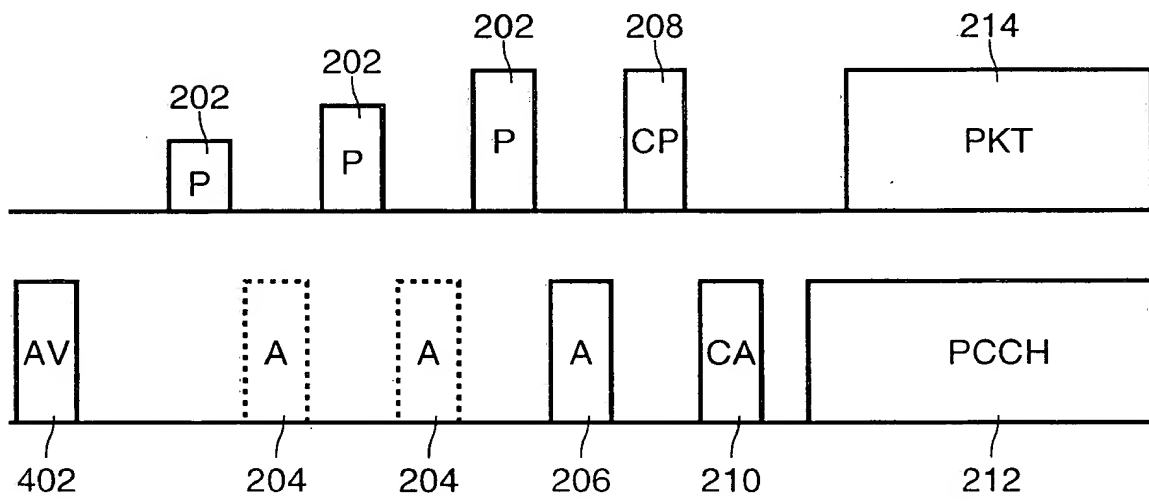


FIG. 4

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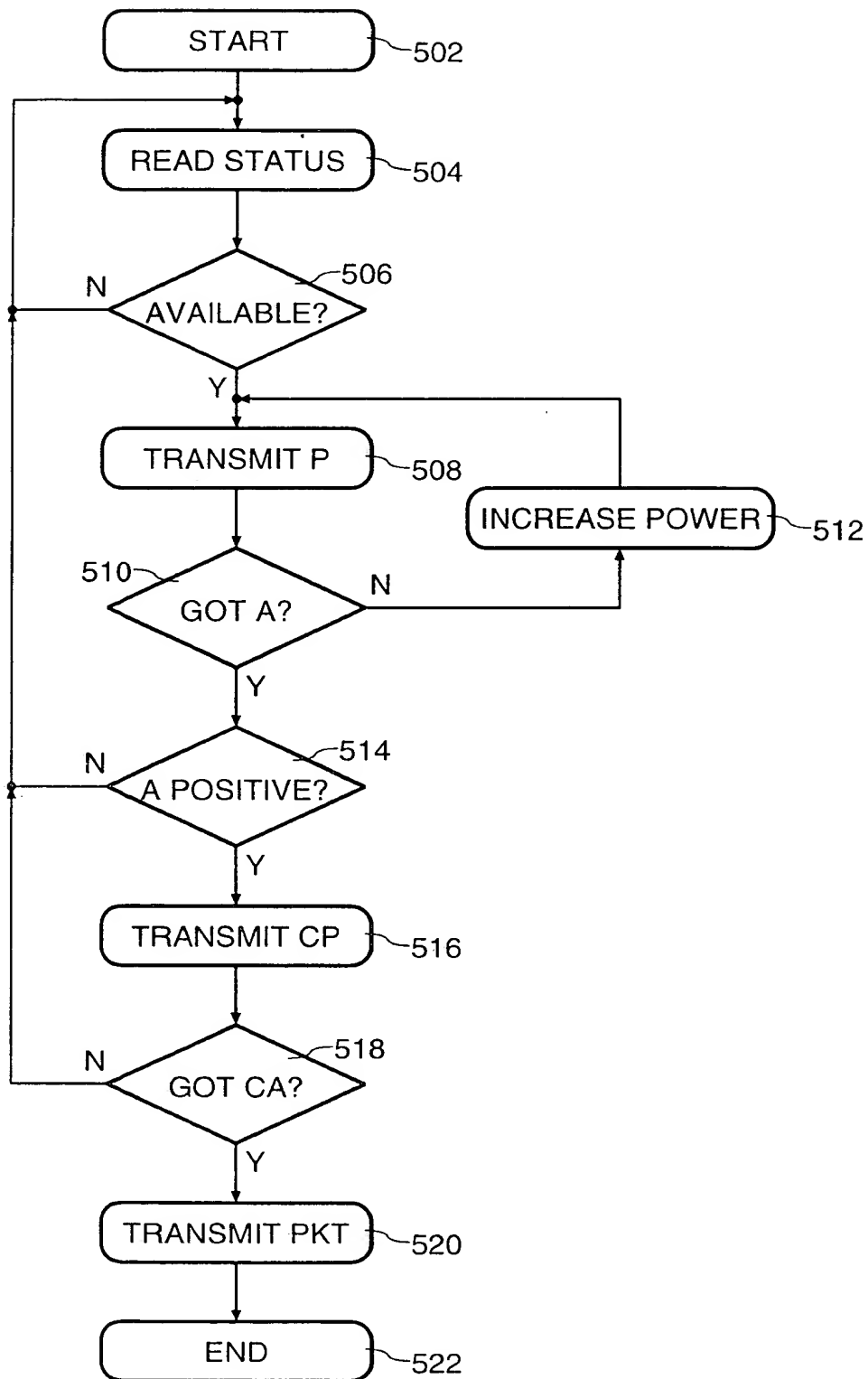


FIG. 5

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